AD-A160 888 VELOCITY RESOLVED SCATTERING OF ATOMIC HYDROGEN FROM SURFACES(U) TEXAS A AND M UNIV COLLEGE STATION DEPT OF PHYSICS E S FRY ET AL. 01 OCT 85 ABL-1 1/1

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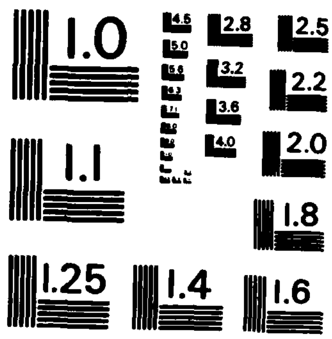

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A stabilized single frequency cw Nd-YAG has been designed and built. It has been used to injection lock a high power pulsed Nd-YAG laser. The system has been used to produce ultraviolet tuneable, narrow linewidth radiation at 2430Å. It is used for two photon excitation of atomic hydrogen. Applications of the latter are discussed, e.g. as a probe for studies of atom-surface scattering and of neutral hydrogen atom detection in fusion plasmas.

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Final Report

ABL-1

"Velocity Resolved Scattering of Atomic Hydrogen from Surfaces"

Contract N00014-80-C-0806, Task NR 392-038

E.S. Fry and D.G. Naugle

Interactions of atomic hydrogen with surfaces are being studied. Results will provide information on the hydrogen atom surface interaction potential, the structure of the surface, surface phonon spectra, atomic hydrogen adsorption energies, and atomic hydrogen spin flip effects. In our new approach to studies of this type, a monochromatic, spin-polarized beam of ground state hydrogen atoms is incident on the surface to be studied. Scattered atoms are observed by driving the resonant two photon transition to the metastable state with a pulsed laser at 2430 A. The speed and direction of the resulting metastables are the same as for the original ground state atoms since the photon momenta are negligible. The metastable atoms are then easily detected at the end of a flight path by Auger emission from a surface. Background signals are negligible (dark noise of the Channeltron). The laser pulse provides the start time so that the time of flight to the detector gives the scattered atom energy. With a pulse energy of 3 millijoules, 17% of the scattered atoms are excited to the metastable state without focussing the laser beam. No surface studies have been completed yet, but work is being continued and surface structure and surface phonon spectra for LiF will be obtained in the near future. This work was

recently described in an invited paper at the 1985 American Physical Society Meeting in Houston[2].

An extension of this system to measurements of neutral atomic hydrogen densities in fusion plasmas has been discussed in a recent paper[1]. The method involves using the two photon excitation scheme to excite hydrogen atoms in the plasma to the 2S state. The plasma environment mixes the 2S and 2P states, resulting in the emission of Lyman α radiation. The spatial distribution of atomic hydrogen in the plasma is determined from measurements of the intensity of the Lyman α radiation. This is an effective solution to an important problem. The results of calculations for the two photon excitation probabilities in our experiments are also given in this paper[1].

In order to obtain the high excitation probability to the 2S state, the 2430A laser radiation must have a Fourier transform limited bandwidth. Halfway through this project, we ran into laser problems that forced us to redesign our laser system to produce the 2430A radiation. The system now consists of a cw dye laser operating at 6300A. The cw laser beam passes through 4 dye amplifiers pumped by the second harmonic of a Nd-YAG laser. The result is Fourier transform limited pulses at 6300A with an energy of 50mJ/pulse. These are frequency doubled using 90° phase match in an RDP crystal to produce Fourier transform limited pulses at 3150A with an energy of 15 mJ/pulse. Finally, these are frequency summed in an angle tuned KDP crystal with the 1.064μ fundamental of the Nd-YAG to produce 2430A. We have obtained 5mJ/pulse at this wavelength whereas only 3mJ/pulse is required in our unfocussed laser beam in order to reach the theoretical peak at which

17% of the atoms are excited to the 2S state. In order for the 2430A pulses to be Fourier transform limited, the Nd-YAG must oscillate in a single axial mode. This was accomplished by using a single frequency, cw Nd-YAG laser to injection lock the high power pulsed Nd-YAG laser.

Since a single frequency, cw Nd-YAG laser is not available commercially, we developed and built it. This has been very successful. The output is 250mW in a single axial mode with a line width of 1MHz. It is locked to a temperature stabilized, confocal reference etalon using polarization spectroscopy. This is a special feature that provides a high speed servo loop without modulation. The laser has operated on two different lines 1064.7A and 1062.0A as has been reported[3].

Publications

1. "Detection of Neutral Hydrogen Atoms in a Fusion Plasma", E.S. Fry, Nuclear Instuments and Methods (1985), in press.

2. "Injection Locked Single Frequency Operation of High Power Pulsed Nd-YAG Laser", S. Henderson and E.S. Fry. In preparation

Papers

3. "Two Photon Excitation of Atomic Hydrogen in a Probe Used for Surface Studies", E.S. Fry, Invited paper at the Houston meeting of the American Physical Society, March 8-9, 1985.

4. "Stabilized Single-Longitudinal Mode Nd:YAG Laser", S.W. Henderson and E.S. Fry, Houston Meeting of the American Physical Society, March 8-9, 1985.

5. "Use of a Hexapole Magnet for Velocity and Spin State Selection of a Hydrogen Beam for Surface Studies", E.H. Yuen and E.S. Fry, Dallas Meeting of the American Vacuum Society, June 3-4, 1985.

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